Geology of the Manti Canyon Area, Sanpete County, Utah

by

Robert C. Davis

The Ohio State University

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CONTENTS

ABSTRACT

The Manti Canyon area is on the east side of Sanpete Valley and includes about 14 square miles north and east of Manti, Utah. The mountainous area on the east side of Sanpete Valley is the Wasatch Plateau. The main structure in this area is the Wasatch monocline. In the Manti Canyon area, five recognizable formations are present. In ascending order, these are the North Horn, Flagstaff, Colton, Green River, and Crazy Hollow Formations. The area was a site of lacustrine and fluviatile deposition during the Upper Cretaceous and Lower Paleocene, floodplain and channel deposits during the lower Eocene and shallow lake deposits during later Eocene time. Deposition of the Crazy Hollow Formation occurred probably in the late Eocene and was followed by orogeny, normal faulting, and formation of the Wasatch monocline. Today the area is one of erosion and downslope movements.

INTRODUCTION

Location and Extent of Area. - - The Manti Canyon area is in Central Utah near Manti, and includes sections 27-29 and 32-34, T. 17S, R3E, and sections 3-10, T 18S, R3E, (See Fig. 1)

Geography and Topography. - - The Manti Canyon area is a mountainous region on the east side of Sanpete Valley and has a topographic relief of about 3,800 feet. The highest point is slightly more than 9,200 feet above sea level, and the lowest point is in Sanpete Valley at about 5,400 feet above sea level.

Previous Work. - - Previous work in the Manti Canyon area has been done by Edmund M. Spieker, James B. Reeside, Charles B. Hunt, Aurele LaRocque, Frank R. Clark, C. L. Gazin, Marland P. Billings, students of Ohio State and Northern Illinois Universities, and others. I worked with Charles Absher and Murray Pastko from Northern Illinois University in the Manti Canyon area during the period July 1 to August 8, 1968. The area was mapped on a topographic map and aerial photographs of the region. The topographic map was used as a base map. Contacts were mapped in most cases on aerial photographs or by triangulation with the brunton compass. Plane tabling was done at the mouth of Manti Canyon by Charles Absher and Murray Pastko, and stratigraphic sections were measured primarily by Murray Pastko and the author. Stratigraphic cross-sections were constructed by Charles Absher. Writeups of economic geology were written by Murray Pastko and the author, structural geology by Murray Pastko,

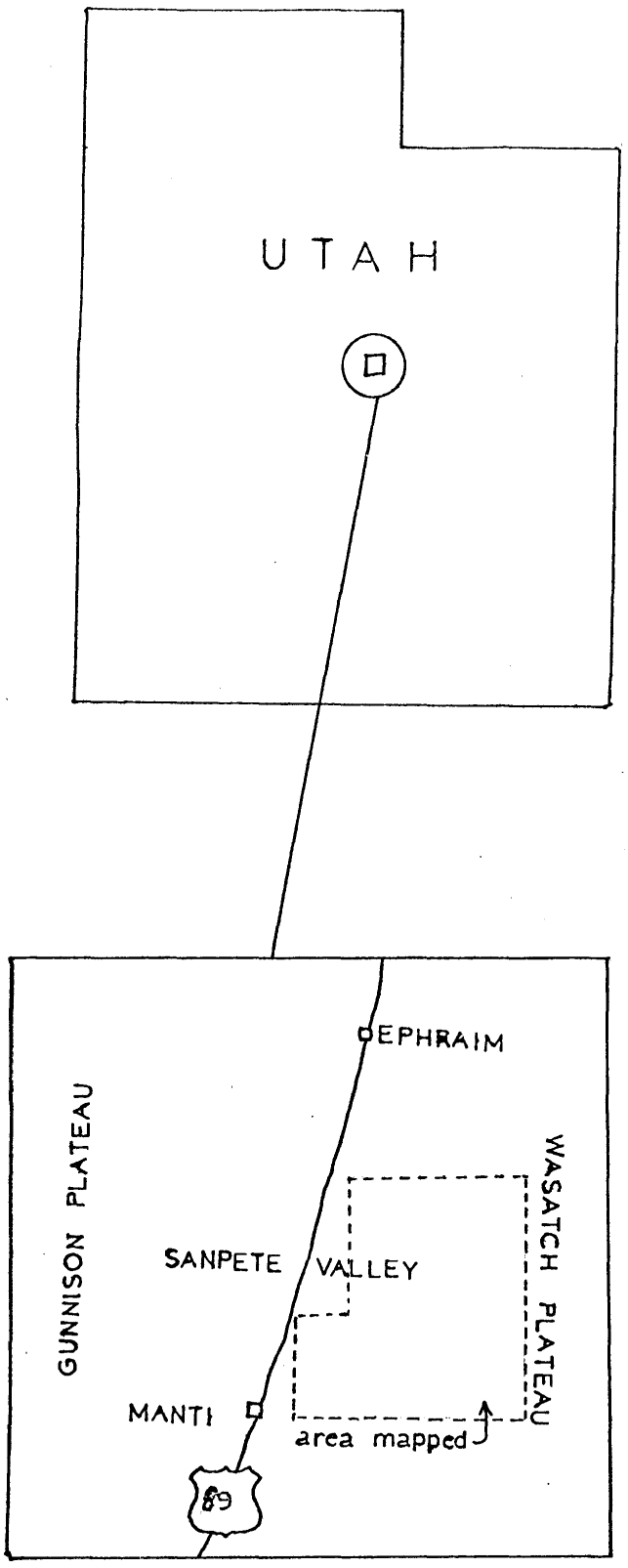

Fig. 1. Index map of central Utah.

geomorphology by Charles Absher and geologic history by Charles Absher and the author. Mapping was done as a group for the first half of the period and then on an individual basis during the last half.

Acknowledgments. -- Our party was aided in mapping in Manti Canyon by Dr. M. P. Weiss of Northern Illinois University, and by Dr. Richard Threet of San Diego State University. We were aided in mapping along Willow Creek by Dr. Richard Threet and in the northwestern part of the area by Dr. Ronald Flemal of Northern Illinois University, Dr. Nickey of Ohio State University, and by Walter Hasenmueller of The Ohio State University.

STRATIGRAPHY

Cretaceous and Tertiary Systems, North Horn Formation

Definition. - - The North Horn Formation is named for its type locality on North Horn Mountain in T's. 18 and 19S., R.6E., Salt Lake meridian (Spieker, 1946). Prior to 1946, the North Horn Formation was considered to be Tertiary in age, but now, due largely to the work of Edmund M. Spieker (1946), the North Horn Formation is considered to be partly Cretaceous and partly Tertiary in age. The generalized section measured on the southwest point of North Horn Mountain, according to Spieker, (1946, p. 133), has the following lithologic characteristics:

		Feet
1.	Shale, red and variegated in upper part, gray in lower part, with interbedded buff and gray sandstone and some limestone, the bedding very even and individual layers thin; lacustrine in origin; forms steep slopes and cut banks beneath limestone cliffs of Flagstaff	250
2.	Shale, gray to variegated, with thin beds of buff sandstone, in general irregularly bedded; floodplain deposits; forms gentle slopes	300
3.	Shale, gray to black; sandstone, buff to light cream and gray, chiefly fine, some limestone, in very evenly bedded succession, layers generally not over 5 feet thick; mainly lacustrine;	

generally capped by resistant sandstone and forming shoulder or terrace with steep front slope 250

4. Shale, gray in lower part, variegated in upper part; sandstone, buff to gray, mainly medium to fine but with conglomerate in places; minor amounts of limestone; dominantly floodplain in origin, forms gentler slopes between Unit 3 and Price River Formation 850

Total North Horn . . . . . 1650 feet

Representative Section. - - Incomplete section of North Horn Formation measured by Robert Davis on north wall of Manti Canyon in SE ¼ NW¼ Sec. 9, T 18S, R3E (Ephraim, Utah quadrangle). Measured with a hand level, corrected for a NW dip of 17°. Section begins at exposure of white sandstone containing a thin bed of coal and proceeds upslope to contact with Flagstaff Limestone.

Unit	Description	Thickness (in ft.)
18	Flagstaff Limestone; gray to white limestone with interbedded light gray mudstones.	
	North Horn Formation	
17	Sandstone; light to dark red, includes some lenses of conglomerate, but many of outcrops covered with mudstones and Flagstaff debris from above	240

16. Sandstone; tan to light red, medium to coarse-grained, stained with hematite 76

15. Sandstone; gray, fine/to medium-grained, clacareous cement, massive 29

14. Sandstone; tan to light red, medium/to coarse-grained, containing lenses of conglomerate and interbedded with gray and red mudstones 148

13. Sandstone; yellow to golden brown, fine-grained, calcareous cement, sand grains well rounded 35

12. Mudstone; red and tan, calcareous, deeply weathered and poorly bedded, probably covering outcrops 74

11. Sandstone; tan, fine-grained, massive, contains thin lenses of conglomerate. Forms steep cliffs 40

10. Mudstone; alternating red and gray, not calcareous, deeply weathered and poorly bedded 34

9. Sandstone; tan to white, very fine grained, and in places is covered by a black weathering product. Sandstone contains thin lenses of conglomerate near base, and entire unit is covered in places by red and gray mudstones . . 46

8. Conglomerate; red to brown, contains black chert, pink and white quartzite and milky quartz pebbles, all subrounded to angular. The conglomerate contains thin beds of sandstone, tan, medium/to fine-grained, poorly cemented and deeply weathered . . . 46

7. Sandstone; red to brown, stained with hematite, medium-grained. Contains thin lenses of red conglomerate composed of subangular fragments of quartz and quartzite. Conglomerate lenses only several inches thick. Whole unit forms cliff 12

6. Mudstone; red, calcareous, tends to slide easily on steep slopes 23

5. Sandstone; red, stained with hematite, fine-grained, with grains well rounded. Massive and forms cliffs 7

4. Mudstone; red, calcareous, eaily eroded, and tends to slide on steep slopes 34

3. Conglomerate; red-brown, contains clear quartz, black chert, and pink quartzite pebbles; most pebbles are well rounded, cemented by silica . . . 4

2. Mudstone; gray and red, calcareous. Forms gentle slopes 43

1. Sandstone; tan to white, fine/to medium-grained, contains pink quartz grains. A 6-inch coal bed is present about 5 feet from the base of the sandstone. Forms cliffs 10

Alluvium to level of Manti Creek

Total North Horn exposed . . . . . 901 Ft.

Stratigraphic relations. - - The contact between the North Horn Formation and the Flagstaff Limestone in the Manti Canyon area is an angular unconformity. The angle of dip of the North Horn Formation is approximately 17° to the west and the dip of the Flagstaff Limestone is approximately 35° to the west in the area where the North Horn Formation was measured. Therefore, the angle representing the angular unconformity is about 18°.

Age and correlation. - - The North Horn is partly Cretaceous and partly Paleocene in age. According to Spieker (1946, p. 134-135), the North Horn Formation is Cretaceous in age up to and including the highest dinosaur zone in the formation, and Paleocene to the top of the formation. According to Spieker (1949, p. 26), the North Horn Formation is one of the most extensive formations in the region. It makes up most of the southern part of the Gunnison Plateau and the western half of the Wasatch Plateau. It is the dominant formation in the Valley Mountains, and is also prominent in Long Ridge, west of Juab Valley, and in the Pavant Range. The gross range of thickness of the North Horn Formation is from 500 feet in lower Salina Canyon to more than 2,800 feet in the Gunnison Plateau and Valley Mountains. It is commonly 1,500 to 2,000 feet thick in the Wasatch Plateau.

TERTIARY SYSTEM

Flagstaff Limestone

Definition. - - Prior to 1946, the Flagstaff Limestone was considered to be the Flagstaff member of the Wasatch Formation of Central Utah. Spieker (1946, p. 121) proposed the establishment of the Flagstaff Limestone as an independent formation. The Flagstaff Limestone was named and defined by Spieker and Reeside (1925, p. 448-449), and according to LaRocque (1960, p. 9), the type section is in the slopes of Flagstaff Peak in Sanpete Canyon, Utah.

Lithologic Characteristics. - - According to Spieker (1946, p. 136), the Flagstaff Limestone consists regionally of freshwater limestone of many kinds, interbedded with gray shale and minor amounts of sandstone, gypsum, oil shale, and volcanic ash. The unit is distinguished from other formations by its white or cream-colored outcrops. In the Wasatch Plaeau, the Flagstaff Limestone averages between 800 and 1,000 feet in thickness.

Representative section. - - Incomplete section of Flagstaff Limestone measured by Murray Pastko and Charles Absher on north side of Willow Creek in Sec. 23, T17S, R3E (Ephraim, Utah, guadrangle). Measured with a hand level, corrected for a NW dip of 35°. Section begins at an exposure of light gray limestone and proceeds upslope to present erosion surface.

Unit	Description	Thickness (in ft.)
14	Mudstone; gray, interbedded with light gray limestones and black chert	105

13. Limestone; light gray, massive, weathers white; highly jointed; chert in lenses and joints 35

12. Mudstone; gray to light green. Grades into brown argillaceous, and dense limestones . 30

11. Limestone; light gray, weathers white in lower part and brown in upper part; interbedded with gray mudstone 25

10. Limestone; white to light gray, dense and massive, weathers white. Contains a small amount of black chert 50

9. Mudstone; light gray, calcareous 80

8. Limestone; light gray, massive, weathers tan, highly jointed 40

7. Mudstone; light gray, calcareous 60

6. Limestone; light to dark gray, highly argillaceous; contains gastropods and pelecypods 95

5. Mudstone; gray. Contains thin beds of black limestone containing gastropods and pelecypods 60

4. Mudstone; gray, interbedded with thin limestone lenses, medium gray, weathers tan to brown 30

3. Limestone; light brown, weathers light yellow, argillaceous, interbedded with gray mudstone 20

2.	limstone; dark gray to brown, argillaceous, interbedded with gray mudstone	30
1.	Limestone; light gray, dense, slightly argillaceous, interbedded with mudstone . . .	40
	Total Flagstaff exposed	690 Ft.

Stratigraphic relations. - - The base of the Flagstaff Formation is not exposed in the area in which the section was measured. As stated before, in the area of Manti Canyon, the contact between the Flagstaff Limestone and the North Horn Formation is an angular unconformity. The top of the Flagstaff Limestone is not exposed in the area where the section was measured either. According to Spieker (1944, p. 33), the Flagstaff Limestone grades into the overlying Colton beds, and locally it intertongues with the Colton Formation.

Age and Correlation. - - The Flagstaff Limestone is probably Paleocene in age, according to Spieker (1949, p. 32). Spieker (1949, p. 31-32) defines the extent of the Flagstaff Limestone as the Long Ridge area, west of Juab Valley on the west; the Wasatch Mountains southeast of Provo on the north; the Sunnyside district in the West Tavaputs Plateau on the east; and possibly in the Bryce Canyon - Cedar Breaks section on the south. LaRocque (1960) in his study of the freshwater molluscan fauna found the age of the Flagstaff Limestone to be decidedly Paleocene.

Colton Formation

Definition. - - Prior to 1946, the Colton Formation was considered to be the Upper member of the Wasatch Formation of Central Utah (Spieker 1946, p. 121). Spieker (1946, p. 121) proposed the adoption of the name Colton for what had been the upper member of the Wasatch Formation of Central Utah. The type area of the Colton Formation is the Price Canyon section of the Wasatch Plateau, and it is named for Colton, Utah, which is about two miles west of the type area (Spieker 1946, p. 139).

Lithologic Characteristics. - - According to Spieker (1946, p. 139), the typical Colton Formation consists of gray, salt and pepper sandstone, greenish-buff sandstone, siltstone that commonly weathers golden brown, and shale ranging from deep red to variegated and gray in color. In the type area at the head of Price Canyon, the Colton Formation is almost exactly 1,500 feet thick.

Representative section. - - Incomplete section of Colton Formation measured by Murray Pastko and Robert Davis on west side of Wasatch monocline in Sec. 8, T18S, R3E (Ephraim, Utah, guadrangle). Measured with a hand level, corrected for a NW dip of 41°. Section begins at an exposure of black chert one inch thick and proceeds downslope to valley level.

Unit	Description	Thickness (in feet)
33.	shale; green, poorly bedded, deeply weathered	10
32.	covered material	344

31.	Shale, green, poorly bedded, deeply weathered	10
30.	Sandstone; green, fine-grained, cross-bedded	10
29.	Mudstone; red and green	130
28.	Sandstone; red-brown, coarse-grained, cross-bedded, shows honeycomb weathering	10
27.	Mudstone; red, interbedded with red sandstone	63
26.	Limestone; white, dense	2
25.	Mudstone; variegated green and blue	130
24.	Limestone; blue, interbedded with blue Mudstones	5
23.	Mudstone; variegated red, blue, and green .	25
22.	Sandstone; variegated red, green, and brown, massive	30
21.	Mudstone; red and green	35
20.	Sandstone; red, very coarse-grained, friable	5
19.	Mudstones; green and red	50
18.	Sandstone; buff, thin-bedded, medium-grained	15
17.	Mudstone; green and red, interbedded with blue limestone	55
16.	Limestone; bright green, interbedded with green and blue mudstones	15
15.	Mudstone; green, jointed and blocky	45

14.	Limestone; green, jointed and blocky	5
13.	Sandstone; green, interbedded with green Mudstone	22
12.	Sandstone; green, medium-grained, interbedded with green mudstone	3
11.	Mudstone; green, calcareous	25
10.	Mudstone; green, thinly laminated	5
9.	Limestone; green to white, cherty	5
8.	Mudstone; brown, clacareous	20
7.	Limestone; tan to light green, argillaceous	10
6.	Mudstone; brown, calcareous	20
5.	Limestone; brown, interbedded with brown shales and mudstones	5
4.	Mudstone; green, calcareous	95
3.	Limestone; green, interbedded with green Mudstone	15
2.	Covered interval	162
1.	Chert, brown to black, blocky	1
	Total Colton exposed	1,298 Ft.

Stratigraphic relations. - - According to Spieker (1949, p. 34), The Colton Formation normally grades into both the Flagstaff and Green River Formations, and it also intertongues with both. This agrees with what is found in the Manti Canyon area.

? see section on TF.

Age and Correlation. - - According to Spieker (1949, p. 34), the age of the Colton Formation is probably early Eocene. The Colton Formation is restricted to the body of the Gunnison Plateau, the northern and western margins of the Wasatch Plateau, and the south-

eastern margin of the Valley Mountains. It is not present in the northwestern part of the Wasatch Plateau because of intergonguing with the Green River Formation.

Green River Formation

Definition and Lithologic characteristics. - - The Green River Formation is named for its type area near Green River, Wyoming. According to Spieker (1946, p. 120), the Green River Formation of Central Utah consists regionally of gray shale, sandstone, oil shale, limestone and volcanic ash.

Representative Section. - - Incomplete section of Green River Formation measured by Murray Pastko and Robert Davis in SC 1/9 T18S, R3E (Ephraim, Utah, quadrangle). Measured with a tape in lower part and with a hand level in the upper part. Section begins in bottom of quarry and proceeds up the quarry wall to the contact with the Crazy Hollow Formation.

Unit	Description	Thickness (in ft.)
5.	Crazy Hollow Formation; red and orange sandstone, siltsone, and shale, white sandstone, and pepper-and-salt sandstone .	
4.	Limestone; white to tan, interbedded with tan to white mudstones. A 6-inch brown chert bed appears 50 feet above unit 3; whole unit is deeply weathered to form a	

	covered interval; an orange tuff bed somewhere in this unit is covered by the weathering debris	85
3.	Shale; green, think and fissile	10
2.	Limestone; tan to white, massive, oolitic .	10
1.	Limestone; tan to white, interbedded with tan to white mudstones or shales	105
	Total Green River exposed	210

Stratigraphic relations. - - According to Spieker (1949, p. 35-36), the Green River Formation follows the Colton Formation in complete transition, but the contact between the Green River Formation and the Crazy Hollow Formation is a disconformity. This agrees with what is found in the Manti Canyon area.

Age and correlation. - - According to Hunt (1956, p. 19-21), the age of the Green River Formation is middle Eocene. The Green River Formation is exposed at the base of the Wasatch Plateau on the north and west and it is present in the upper levels of the Gunnison Plateau. It occurs at the bases of the Valley Mountains and the Pavant in the vicinity of Round Valley (Spieker, p. 35). According to Hunt (1956, p. 21), the Green River Formation underlies the Uinta Basin and extends northward into the Wyoming Basin.

Crazy Hollow Formation

Definition. - - Edmund M. Spieker (1949, p. 36), proposed the name Crazy Hollow Formation for the unit that overlies the Green River Formation and underlies the Gray Gulch Formation. The type

locality is in Crazy Hollow, Utah, and it is about 600 feet thick in this area.

Lithologic characteristics. - - Spieker (1949, p. 36) defines the Crazy Hollow Formation as a unit of red and orange sandstone, siltstone and shale, white sandstone, and pepper-and-salt sandstone.

Representative section. - - Incomplete section of Crazy Hollow Formation measured by Murray Pastko and Robert Davis in SC 1/9 T 18S, R3E (Ephraim, Utah, quadrangle). Measured with a tape and hand level, corrected for a NW dip of 24°. Section begins at contact of Green River Formation and Crazy Hollow Formation and proceeds to the uppermost part of the Crazy Hollow exposure.

Unit	Description	Thickness (in Ft.)
2.	Conglomerate; red, sandy, containing quartzite and chert pebbles; marked by distinctive potholes on top of formation . .	20
1.	Sandstone; green, cross-bedded, contains a few black chert grains	5
	Total Crazy Hollow exposed	25 Ft.

Stratigraphic relations. - - According to Spieker (1949, p. 36), at all places where the base of the Crazy Hollow Formation has been discerned, the Crazy Hollow beds lie disconformably on the Green River or on older beds. Near Temple Hill in the Manti Canyon area, the Crazy Hollow Formation lies disconformably on the Green River Formation.

Age and correlation. - - According to Spieker (1949, p. 36),

the age of the Crazy Hollow Formation is not known, but it is probably Eocene and may be late Eocene. The Crazy Hollow Formation can be traced along the base of the Wasatch monocline between Willow Creek and Salina Creek, in Crazy Hollow and the district to the south, and in the foothills of the Wasatch Plateau immediately to the south. It is also present near the Manti Temple, Spring City in Sanpete Valley, and on the west side of the Gunnison Plateau.

STRUCTURAL GEOLOGY

Regional Structure

Sanpete Valley area. - - The Manti Canyon area is on the east side of Sanpete Valley, a structural depression in Central Utah. The east side of this valley is formed by the Wasatch Plateau. The major structure in the area is the Wasatch monocline, and the Manti Canyon area is almost entirely on the dip slope of the monocline. The monocline dips west and flattens out beneath Sanpete Valley, the west edge of which is marked by a normal fault that is down-thrown on the east side.

Local Structure

Folds. - - Aside from the Wasatch monocline, which includes a large portion of the Manti Canyon area, there is a minor syncline just east of Temple Hill in SC 1/9 Sec. 6 T18S, R3E (Ephraim, Utah, quadrangle). The axis of the fold strikes approximately N 10°E. The west limb of the fold dips nearly 25°E and the east limb of the fold dips 11°W. The axial plane dips west at approximately 60°. The Crazy Hollow Formation is in the middle of the syncline and the Green River Formation makes up the outside part of the structure.

Faults. - - The large normal fault located in Sanpete Valley is the major fault in the Sanpete Valley area. According to Spieker (1949, p. 45), the large normal fault occurs somewhere in Sanpete Valley, probably near the Gunnison front (on the west side of Sanpete Valley,

see Fig. 1), and curves steeply downward and eastward toward the roots of the Wasatch Plateau. In the Manti Canyon area, three antithetic faults are exposed in the SC 1/9 Sec. 3 T 18S, R3E (Ephraim, Utah, guadrangle). According to Spieker (1949, p. 45), this system of anti= thetic faults extends for the full length of the monocline, roughly parallel to its major trend but swinging more nearly north. The mono-cline strikes generally N.20-30°E. (Spieker, 1949, p. 44). In the Temple Hill area, a low-angle thrust fault in SC 1/9 Sec. 6, T 18S, R3E (Ephraim, Utah quadrangle), places the Green River Formation on top of the Crazy Hollow Formation. This fault strikes nearly N 5°E and dips about 45°east.

Unconformities. - - The only unconformities present in the Manti Canyon area are the ones between the Green River Formation and the Crazy Hollow Formation, and between the North Horn Formation and the Flagstaff Limestone. The unconformity between the Green River Forma-tion and the Crazy Hollow Formation is a disconformity, and the un-conformity between the North Horn Formation and the Flagstaff Lime-stone is an angular unconformity, of local origin in the area of Manti Canyon. According to Spieker (1949, p. 28), this angular unconformity extends into Sixmile Canyon and the southern part of the Gunnison Plateau.

GEOLOGIC HISTORY

According to Spieker & Reeside (1925, p. 452-453), during the post-Price River and pre-Wasatch period, mountain building was occurring to the west of present day Sanpete Valley. Material from these mountains was quickly eroded and deposited as the North Horn Formation. According to Spieker (1946, p. 133), the North Horn Formation represents an alternation between fluviatile and lacustrine deposits. At the type locality of the North Horn Formation on North Horn Mountain, units 1 and 3 seem to be lake deposits, while units 2 and 4 are typical channel and flood-plain deposits. During Paleocene time, mountain building decreased, and temporary lake basins were formed. In these lake basins fresh water limestones were deposited. These deposits were the Flagstaff Limestone deposits of the Paleocene. After deposition of the Flagstaff, Limestone, broad flats were formed, on which the Colton Formation was deposited. According to Spieker (1946), the Colton Formation was a flood-plain and channel deposit. These broad flats then gave way to shallow lakes wherein the Green River Formation was deposited. This was the end of the sedimentary record for awhile. The next event was volcanism, occurring mostly south of the present plateau (Spieker and Reeside, 1925, p. 452-453). Deposition of the Crazy Hollow Formation of questionable origin, was the next event, and then uplift of the entire region occurred, probably (according to Spieker, 1925, p. 453) in

Late Tertiary time. This uplift moved these rocks to the positions observed today. During the latter stages of the uplift, the rocks in the area were displaced by normal faults and antithetic faults (along the north wall of Manti Canyon) and the major normal fault in Sanpete Valley along with tensional stresses gave rise to the Wasatch monocline. During the formation of the monocline, compressive stresses gave rise to the thrust fault in the Temple Hill area. Stream erosion and deposition cut out the Sanpete Valley area and covered it with alluvium. Erosional remnants of Green River Formation in the form of cuestas, still remain in Sanpete Valley but are deeply weathered. The present topography along the monocline is developed on a dip-slope, and debris slides and debris flows are important in the present day erosion of the area.

why not alphabetic order?

REFERENCES CITED

Spieker, Edmund M., 1949, Guidebook to the Geology of Utah, Utah Geological Society, Salt Lake City, Utah, pp. 1-106.

Spieker, Edmund M., 1945, Late Mesozoic and Early Cenozoic History of Central Utah, U.S. Geol. Survey Prof. Paper 205D, pp. 117-161.

Spieker, E.M., and Reeside, J.B.,Jr., 1925, Cretaceous and Tertiary formations of the Wasatch Plateau: Geol. Soc. America Bull., v. 36, no. 3, p. 435-454.

Hunt, Charles B., 1956, Cenozoic Geology of the Colorado Plateau, U.S. Geol. Survery Prof. Paper 279, pp. 1-87.

LaRocque, Aurèle, 1960, Molluscan Faunas of the Flagstaff Formation of Central Utah, Geol. Soc. America, Mem. 78, p. 1-100.